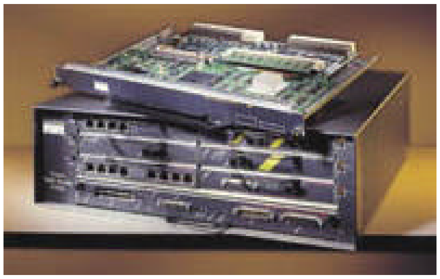
7206 VXR NPE-400 Router with VPN Acceleration Module (VAM)



FIPS 140-2 Non-Proprietary Security Policy

Level 2 Validation

October 7, 2003

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Introduction

Purpose

This is a non-proprietary Cryptographic Module Security Policy for Cisco Systems. This security policy describes how the 7206 VXR NPE-400 with VPN Acceleration Module (VAM) (Hardware Version: 7206-VXR; VAM: Hardware Version 1.0, Board Version A0; Firmware Version: IOS 12.3(3a)) meets the security requirements of FIPS 140-2 and how to run the module in a secure FIPS 140-2 mode. This policy was prepared as part of the Level 2 FIPS 140-2 validation of the module.

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FIPS 140-2 (Federal Information Processing Standards Publication 140-2 — *Security Requirements for Cryptographic Modules*) details the U.S. Government requirements for cryptographic modules. More information about the FIPS 140-2 standard and validation program is available on the NIST website at http://csrc.nist.gov/cryptval/.

References

This document deals only with operations and capabilities of the module in the technical terms of a FIPS 140-2 cryptographic module security policy. More information is available on the module from the following sources:

- The Cisco Systems, Inc. website (www.cisco.com) contains information on the full line of products from Cisco Systems, Inc.

- The NIST Validated Modules website (http://csrc.ncsl.nist.gov/cryptval/): contains contact information for answers to technical or sales-related questions for the module

Document Organization

The Security Policy document is one document in a complete FIPS 140-2 Submission Package. In addition to this document, the complete Submission Package contains:

- Vendor Evidence document
- Finite State Machine
- Module Software Listing
- Other supporting documentation as additional references

This Security Policy and the other validation submission documentation was produced by Corsec Security, Inc. under contract to Cisco Systems, Inc. With the exception of this Non-Proprietary Security Policy, the FIPS 140-2 Validation Submission Documentation is proprietary to Cisco Systems, Inc. and is releasable only under appropriate non-disclosure agreements. For access to these documents, please contact Cisco Systems, Inc.

CISCO 7206 VXR NPE-400 WITH VAM

Overview

The 7200 VXR routers are designed to support gigabit capabilities and to improve data, voice, and video integration in both service provider and enterprise environments. Cisco 7200 VXR routers support a high-speed network services engine (NSE) as well as the high-speed network processing engine, NPE-400, and all other available network processing engines.

Cisco 7200 VXR routers accommodate a variety of network interface port adapters and an I/O controller. A Cisco 7200 VXR router equipped with an NPE-400 can support up to six high-speed port adapters and can also support higher-speed port adapter interfaces including Gigabit Ethernet and OC-12 ATM. Cisco 7200 VXR routers also contain bays for up to two AC-input or DC-input power supplies.

Cisco 7200 VXR routers support the following features:

- Online insertion and removal (OIR)—Add, replace, or remove port adapters without interrupting the system.
- Dual hot-swappable, load-sharing power supplies—Provide system power redundancy; if one power supply or power source fails, the other power supply maintains system power without interruption. Also, when one power supply is powered off and removed from the router, the second power supply immediately takes over the router power requirements without interrupting normal operation of the router.
- Environmental monitoring and reporting functions—Maintain normal system operation by resolving adverse environmental conditions prior to loss of operation.
- Downloadable software—Load new images into Flash memory remotely, without having to physically access the router.

Cryptographic Module

The Cisco 7200 VXR with VAM is a multiple-chip standalone cryptographic module. The Cisco 7206VXR supports multi-protocol routing and bridging with a wide variety of protocols and port adapter combinations available for Cisco 7200 series routers. The metal casing that fully encloses the module establishes the cryptographic boundary for the router, all the functionality discussed in this document is provided by components within the casing. The Cisco 7206VXR has six slots for port adapters, one slot for an input/output (I/O) controller, and one slot for a network processing engine or network services engine.

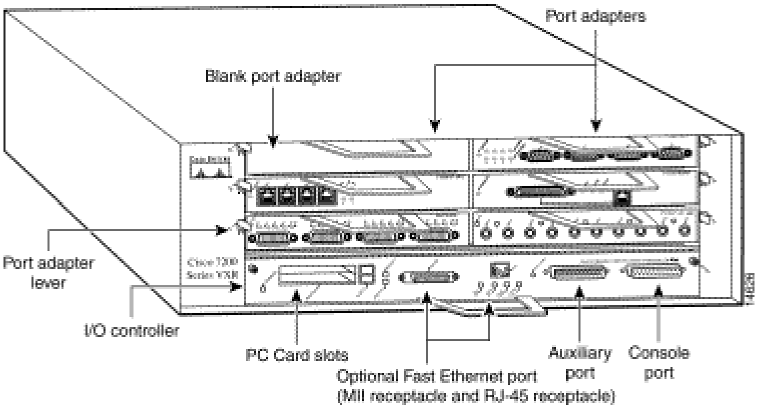

Figure 1 - The 7206 VXR NPE-400 Router

The NPE-400 uses an RM7000 microprocessor that operates at an internal clock speed of 350 MHz. The NPE-400 uses SDRAM for storing all packets received or sent from network interfaces. The SDRAM memory array in the system allows concurrent access by port adapters and the processor. The NPE-400 has three levels of cache: a primary and a secondary cache that are internal to the microprocessor, and a tertiary 4-MB external cache that provides additional high-speed storage for data and instructions.

The Cisco 7206VXR router comes equipped with one 280W AC-input power supply. (A 280W DC-input power supply option is available.) A power supply filler plate is installed over the second power supply bay. A fully configured Cisco 7206VXR router operates with only one installed power supply; however, a second, optional power supply of the same type provides hot-swappable, load-sharing, redundant power.

Module Interfaces

The interfaces for the router are located on the front panel Input/Output (I/O) Controller, with the exception of the power switch and power plug. The module has two Fast Ethernet (10/100 RJ-45) connectors for data transfers in and out. The module also has two other RJ-45 connectors for a console terminal for local system access and an auxiliary port for remote system access or dial backup using a modem.

The figure below shows the front panel LEDs, which provide overall status of the router operation. The front panel displays whether or not the router is booted, if the redundant power is attached and operational, and overall activity/link status.

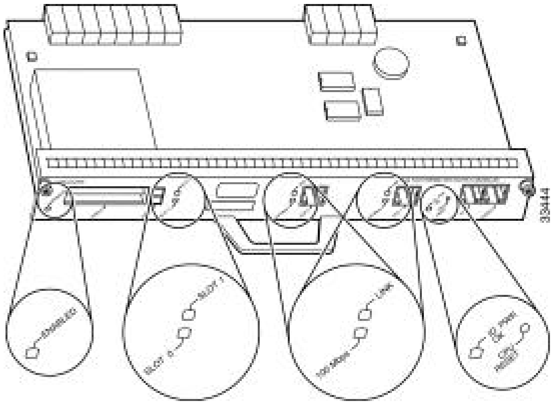

Figure 2 – Front Panel LEDs

LED	Indication	Description
Enabled	Green	Indicates that the network processing engine or network services engine and the I/O controller are enabled for operation by the system; however, it does not mean that the Fast Ethernet port on the I/O controller is functional or enabled. This LED goes on during a successful router boot and remains on during normal operation of the router.
IO POWER OK	Amber	Indicates that the I/O controller is on and receiving DC power from the router midplane. This LED comes on during a successful router boot and remains on during normal operation of the router.
	Off	Powered off or failed.
Slot 0 Slot 1	Green	These LEDs indicate which PC Card slot is in use by coming on when either slot is being accessed by the system. These LEDs remain off during normal operation of the router.
Link	Green	Indicates that the Ethernet RJ-45 receptacle has established a valid link with the network.
	Off	This LED remains off during normal operation of the router unless there is an incoming carrier signal.
100 Mbps	Green	Indicates that the port is configured for 100-Mbps operation (speed 100), or if configured for auto negotiation (speed auto), the port has detected a valid link at 100 Mbps.
	Off	If the port is configured for 10-Mbps operation, or if it is configured for auto negotiation and the port has detected a valid link at 10 Mbps, the LED remains off.

Table 1 – Front Panel LEDs and Descriptions

The VPN Acceleration Module (VAM) is a single-width acceleration module that provides high-performance, hardware-assisted tunneling and encryption services suitable for virtual private network (VPN) remote access, site-to-site intranet, and extranet applications. It also provides platform scalability and security while working with all services necessary for successful VPN deployments—security, quality of service (QoS), firewall and intrusion detection, and service-level validation and management. The VAM off-loads IPSec processing from the main processor, thus freeing resources on the processor engines for other tasks.

The VAM has three LEDs, as shown below. Table 2 lists the colors and functions of the VAM LEDs.

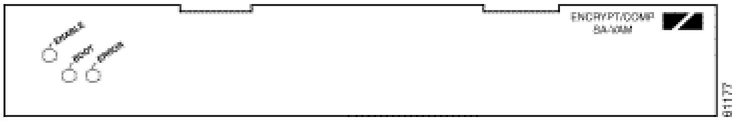

Figure 3 – VAM LEDs

LED Label	Color	State	Function
ENABLE	Green	On	Indicates the VAM is powered up and enabled for operation.
BOOT	Amber	Pulses	Indicates the VAM is operating.
		On	Indicates the VAM is booting or a packet is being encrypted or decrypted.
ERROR	Amber	On	Indicates an encryption error has occurred. This LED is normally off.

Table 2 – VAM LEDs and Descriptions

All of these physical interfaces are separated into the logical interfaces from FIPS as described in the following table:

Router Physical Interface	FIPS 140-2 Logical Interface
10/100BASE-TX LAN Port Port Adapter Interface Console Port Auxiliary Port PCMCIA Slot	Data Input Interface
10/100BASE-TX LAN Port Port Adapter Interface Console Port Auxiliary Port PCMCIA Slot	Data Output Interface
Power Switch Console Port Auxiliary Port	Control Input Interface
10/100BASE-TX LAN Port LEDs Enabled LED PCMCIA LEDs IO Pwr Ok LED VAM LEDs Console Port Auxiliary Port	Status Output Interface

Router Physical Interface	FIPS 140-2 Logical Interface
Power Plug	Power Interface

Table 3 – FIPS 140-2 Logical Interfaces

In addition to the built-in interfaces, the router also has additional port adapters that can optionally be placed in an available slot. These port adapters have many embodiments, including multiple Ethernet, token ring, and modem cards to handle frame relay, ATM, and ISDN connections.

Roles and Services

Authentication is role-based. There are two main roles in the router that operators may assume: the Crypto Officer role and the User role. The administrator of the router assumes the Crypto Officer role in order to configure and maintain the router using Crypto Officer services, while the Users exercise only the basic User services. The module supports RADIUS and TACACS+ for authentication. A complete description of all the management and configuration capabilities of the Cisco 7206 Router can be found in the *Performing Basic System Management* manual and in the online help for the router.

Crypto Officer Services

During initial configuration of the router, the Crypto Officer password (the “enable” password) is defined. A Crypto Officer may assign permission to access the Crypto Officer role to additional accounts, thereby creating additional Crypto Officers.

The Crypto Officer role is responsible for the configuration and maintenance of the router. The Crypto Officer services consist of the following:

- **Configure the router**: define network interfaces and settings, create command aliases, set the protocols the router will support, enable interfaces and network services, set system date and time, and load authentication information.

- **Define Rules and Filters**: create packet Filters that are applied to User data streams on each interface. Each Filter consists of a set of Rules, which define a set of packets to permit or deny based characteristics such as protocol ID, addresses, ports, TCP connection establishment, or packet direction.

- **Status Functions**: view the router configuration, routing tables, active sessions, use Gets to view SNMP MIB II statistics, health, temperature, memory status, voltage, packet statistics, review accounting logs, and view physical interface status

- **Manage the router**: log off users, shutdown or reload the outer, manually back up router configurations, view complete configurations, manager user rights, and restore router configurations.

- **Set Encryption/Bypass**: set up the configuration tables for IP tunneling. Set keys and algorithms to be used for each IP range or allow plaintext packets to be set from specified IP address.

- **Change WAN Interface Cards**: insert and remove WICs in the WAN interface slot as described in Section 0, Number 2 of this document.

User Services

A User enters the system by accessing the console port with a terminal program. The IOS prompts the User for their password. If the password is correct, the User is allowed entry to the IOS executive program. The services available to the User role consist of the following:

- **Status Functions**: view state of interfaces, state of layer 2 protocols, version of IOS currently running

- **Network Functions**: connect to other network devices through outgoing telnet, PPP, etc. and initiate diagnostic network services (i.e., ping, mtrace)

- **Terminal Functions:** adjust the terminal session (e.g., lock the terminal, adjust flow control)

- **Directory Services**: display directory of files kept in flash memory

Physical Security

The router is entirely encased by a thick steel chassis. The front of the router provides 6 port adapter slots, on-board LAN connectors, PC Card slots, and Console/Auxiliary connectors. The power cable connection, a power switch, and the access to the Network Processing Engine are at the rear of the router.

Once the router has been configured to meet FIPS 140-2 Level 2 requirements, the router cannot be accessed without signs of tampering. To seal the system, apply serialized tamper-evidence labels as follows:

- Clean the cover of any grease, dirt, or oil before applying the tamper evidence labels. Alcohol-based cleaning pads are recommended for this purpose. The ambient air must be above 10C, otherwise the labels may not properly cure.

- The tamper evidence label should be placed so that the one half of the label covers the enclosure and the other half covers the 7206 VXR NPE-400 Input/Output Controller.

- The tamper evidence label should be placed over the Flash PC Card slots on the Input/Output Controller.

- The tamper evidence label should be placed so that one half of the label covers the enclosure and the other half covers the port adapter slot 1.

- The tamper evidence label should be placed so that one half of the label covers the enclosure and the other half covers the port adapter slot 2.

- The tamper evidence label should be placed so that one half of the label covers the enclosure and the other half covers the port adapter slot 3.

- The tamper evidence label should be placed so that one half of the label covers the enclosure and the other half covers the port adapter slot 4.

- The tamper evidence label should be placed so that one half of the label covers the enclosure and the other half covers the port adapter slot 5.

- The tamper evidence label should be placed so that one half of the label covers the enclosure and the other half covers the port adapter slot 6.

- The tamper evidence label should be placed so that one half of the label covers the enclosure and the other half covers the network processing engine.

- The tamper evidence label should be placed so that one half of the label covers the enclosure and the other half covers the power supply plate.

- The tamper evidence label should be placed so that one half of the label covers the enclosure and the other half covers the redundant power supply plate.

The labels completely cure within five minutes.

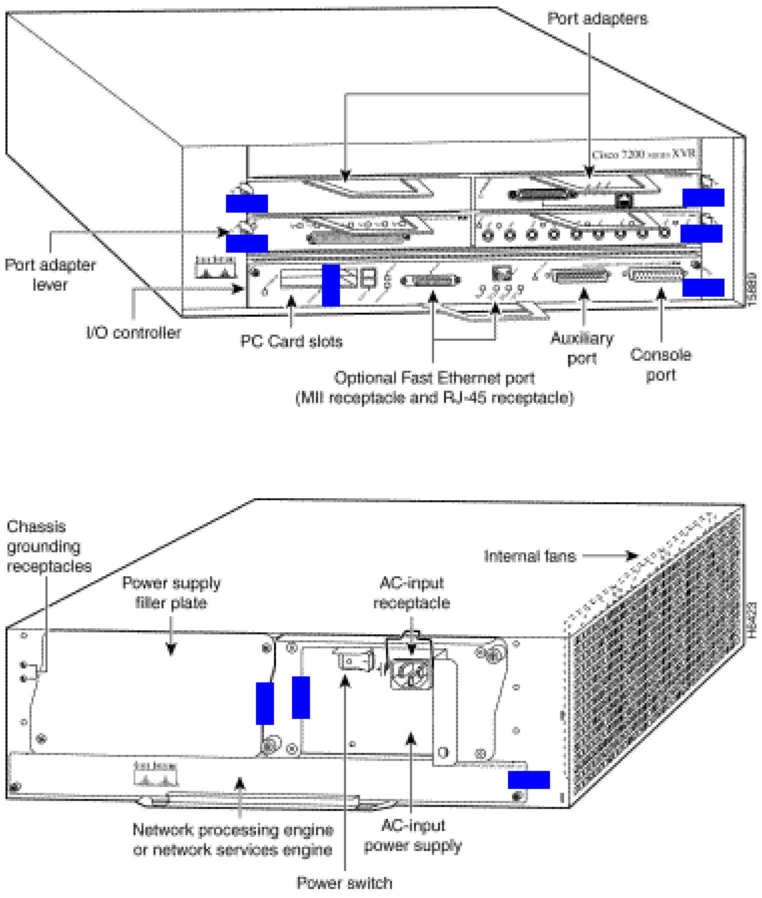

Figure 4 – Tamper Evidence Label Placement

Cryptographic Key Management

The router securely administers both cryptographic keys and other critical security parameters such as passwords. The tamper evidence seals provide physical protection for all keys. Keys are also password protected and can be zeroized by the Crypto Officer. Keys are exchanged manually and entered electronically via manual key exchange or Internet Key Exchange (IKE).

The modules contain a cryptographic accelerator card, which provides DES (56-bit), and 3DES (168-bit) IPSec encryption, MD5 and SHA-1 hashing, and has hardware support for DH and RSA key generation.

The module supports the following keys (critical security parameters):

- IPSEC Session
- IKE Key-pairs

- IKE Public
- Pre-shared
- DH Key-pairs
- X9.31 PRNG Seed Key

The module supports DES, 3DES, DES-MAC, TDES-MAC, AES, SHA-1, HMAC SHA-1, MD5, MD4, MD5 HMAC, Diffie-Hellman, RSA (for digital signatures and encryption/decryption), cryptographic algorithms. The MD5, HMAC MD5, MD4, and RSA encryption/decryption algorithms are disabled when operating in FIPS mode.

The module supports three types of key management schemes:

1. Manual key exchange method that is symmetric. DES/3DES/AES key and HMAC-SHA key are exchanged manually and entered electronically.
2. Internet Key Exchange method with support for exchanging pre-shared keys manually and entering electronically.
    - The pre-shared keys are used with Diffie-Hellman key agreement technique to derive DES, 3DES or AES keys.
    - The pre-shared key is also used to derive HMAC-SHA key.
3. Internet Key Exchange with RSA-signature authentication.

The module supports commercially available methods of key establishment, including Diffie-Hellman and IKE. See the Configuring IPSec Network Security document, Submission Document 7A, and the Internet Key Exchange Security Protocol Commands, Submission Document 7B.

All pre-shared keys are associated with a password of the role that created the keys. The Crypto Officer needs to be authenticated to store keys. All Diffie-Hellman (DH) keys agreed upon for individual tunnels are directly associated with that specific tunnel only via the IKE protocol.

Key Zeroization:

Each key can be zeroized by sending the “no” command prior to the key function commands. This will zeroize each key from the DRAM, which is a running configuration. The Crypto Officer must copy the running configuration (DRAM) to the start-up configuration (NVRAM) in order to completely zeroize the keys. Additionally, the Crypto Officer can zeroize all operator passwords by overwriting them with spaces or by deleting the operators' access.

"Clear Crypto IPSec SA" will zeroize the DES session key (which is derived using the Diffie-Hellman key agreement technique) from the DRAM. This session key is only available in the DRAM; therefore this command will completely zeroize this key. The following command will zeroize the manual keys from the DRAM:

- no set session-key inbound ah spi hex-key-data
- no set session-key outbound ah spi hex-key-data
- no set session-key inbound esp spi cipher hex-key-data [authenticator hex-key-data]
- no set session-key outbound esp spi cipher hex-key-data [authenticator hex-key-data]

The DRAM running configuration must be copied to the start-up configuration in NVRAM in order to completely zeroize the keys.

The following commands will zeroize the pre-shared keys from the DRAM:

- no crypto isakmp key key-string address peer-address
- no crypto isakmp key key-string hostname peer-hostname

The DRAM running configuration must be copied to the start-up configuration in NVRAM in order to completely zeroize the keys.

Self-Tests

In order to prevent any secure data from being released, it is important to test the cryptographic components of a security module to insure all components are functioning correctly. The router includes an array of self-tests that are run during startup and periodically during operations. An example of the self-tests run at power-up is a cryptographic known answer test (KAT) on each of the FIPS-approved cryptographic algorithms and on the Diffie-Hellman algorithm. Examples of tests performed at startup are a software integrity test using an EDC, and a set of Statistical Random Number Generator (RNG) tests. Examples of tests run periodically or conditionally include: a bypass mode test performed conditionally prior to executing IPSec, and a continuous random number generator test. If any of the self-tests fail, the router transitions into an error state. Within the error state, all secure data transmission is halted and the router outputs status information indicating the failure.

SECURE OPERATION

Cisco 7206 VXR NPE-400 router meets all the Level 2 requirements for FIPS 140-2. Follow the setting instructions provided below to place the module in FIPS mode. Operating this router without maintaining the following settings will remove the module from the FIPS approved mode of operation.

Initial Setup

1. The Crypto Officer must apply tamper evidence labels as described in the Physical Security section of this document.

2. Only a Crypto Officer may add and remove WAN Interface Cards. When removing the tamper evidence label, the Crypto Officer should remove the entire label from the router and clean the cover of any grease, dirt, or oil with an alcohol-based cleaning pad. The Crypto Officer must re-apply tamper evidence labels on the router as described in the Physical Security section of this document.

3. The Crypto Officer must disable IOS Password Recovery by executing the following commands:

   ```
   configure terminal

   no service password-recovery

   end

   show version
   ```

   NOTE: Once Password Recovery is disabled, administrative access to the module without the password will not be possible.

System Initialization and Configuration

1. The Crypto Officer must perform the initial configuration. The IOS version 12.3(3a), is the only allowable image. No other image may be loaded.

2. The value of the boot field must be 0x0101 (the factory default). This setting disables break from the console to the ROM monitor and automatically boots the IOS image. From the “configure terminal” command line, the Crypto Officer enters the following syntax:

   ```
   config-register 0x0101
   ```

3. The Crypto Officer must create the “enable” password for the Crypto Officer role. The password must be at least 8 characters

and is entered when the Crypto Officer first engages the “enable” command. The Crypto Officer enters the following syntax at the “#” prompt:

```
enable secret [PASSWORD]
```

4. The Crypto Officer must always assign passwords (of at least 8 characters) to users. Identification and authentication on the console port is required for Users. From the “configure terminal” command line, the Crypto Officer enters the following syntax:

```
line con 0

password [PASSWORD]

login local
```

5. The Crypto Officer shall only assign users to a privilege level 1 (the default).

6. The Crypto Officer shall not assign a command to any privilege level other than its default.

IPSec Requirements and Cryptographic Algorithms

There are two types of key management method that are allowed in FIPS mode: Internet Key Exchange (IKE) and IPSec manually entered keys.

Although the IOS implementation of IKE allows a number of algorithms, only the following algorithms are allowed in a FIPS 140-2 configuration:

- ah-sha-hmac
- esp-des
- esp-sha-hmac
- esp-3des
- esp-aes

The following algorithms are not FIPS approved and should be disabled:

- RSA for encryption
- MD-4 and MD-5 for signing
- MD-5 HMAC

Protocols

1. SNMP v3 over a secure IPSec tunnel may be employed for authenticated, secure SNMP *gets* and *sets*. Since SNMP v2C uses community strings for authentication, only *gets* are allowed under SNMP v2C.

Remote Access

1. Telnet access to the module is only allowed via a secure IPSec tunnel between the remote system and the module. The Crypto officer must configure the module so that any remote connections via telnet are secured through IPSec.

2. SSH access to the module is only allowed if SSH is configured to use a FIPS-approved algorithm. The Crypto officer must configure the module so that SSH uses only FIPS-approved algorithms.

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